On the Conjugacy of Auroral Afternoon Bright Spots

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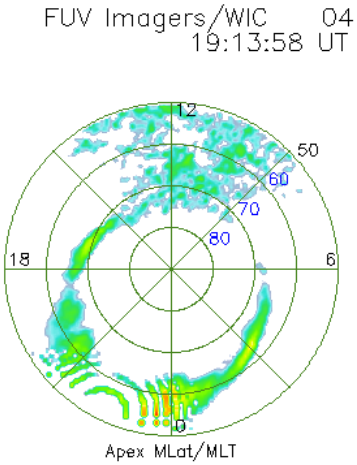
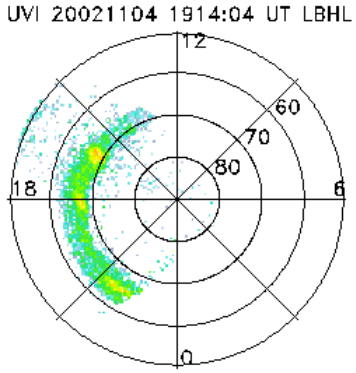


Northern Hemisphere
IMAGE WIC

←

→

Southern Hemisphere
Polar UVI



Polar Contributions to Auroral Conjugacy

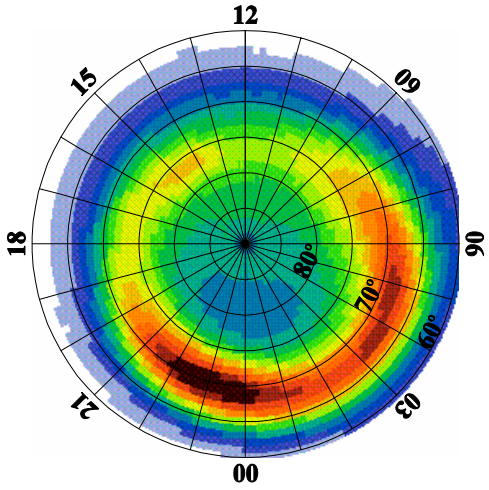
- VIS – Simultaneous observations of both hemispheres with a single imager
- VIS/IMAGE FUV – Observations in opposite hemispheres with comparable instruments
- UVI/IMAGE FUV
- . . .

- Conjugate behavior during substorms
  - Timing differences
  - Longitudinal shifts – dependence on IMF
- Conjugate "whole oval" behavior for varying IMF conditions
- Conjugate behavior of the dayside aurora
- . . .

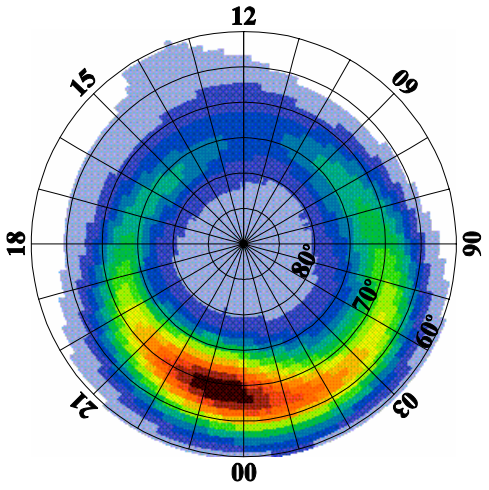
The afternoon auroral bright spot

- Is located near 15 MLT and 75^{o} ILAT
- Is persistent in image data [Cogger et al., 1977; Liou et al., 1997] and particle data [McDiarmid et al., 1975; Newell et al., 1996]
- Is co-located with a statistical maximum in upward field-aligned current (R1 current) [Iijima and Potemra, 1978; Liou et al., 1999]
- Is influenced by IMF; more common when $B_y > 0$ [Murphree et al., 1981; Vo and Murphree, 1995]
- Can be structured and dynamic ("string of pearls" configuration) [Lui et al., 1987; Potmra et al., 1990; Rostoker et al., 1992]
- Varies with season: Stronger in summrt than in winter [Liou et al., 2001] Summer in one hemisphere, winter in the other → hemispheric difference

Summer



Winter



(from Liou et al., 2001)

- All previous studies of dayside auroral conjugacy have been limited by local observations (either in-situ point measurements or ground based instruments) in at least one hemisphere.

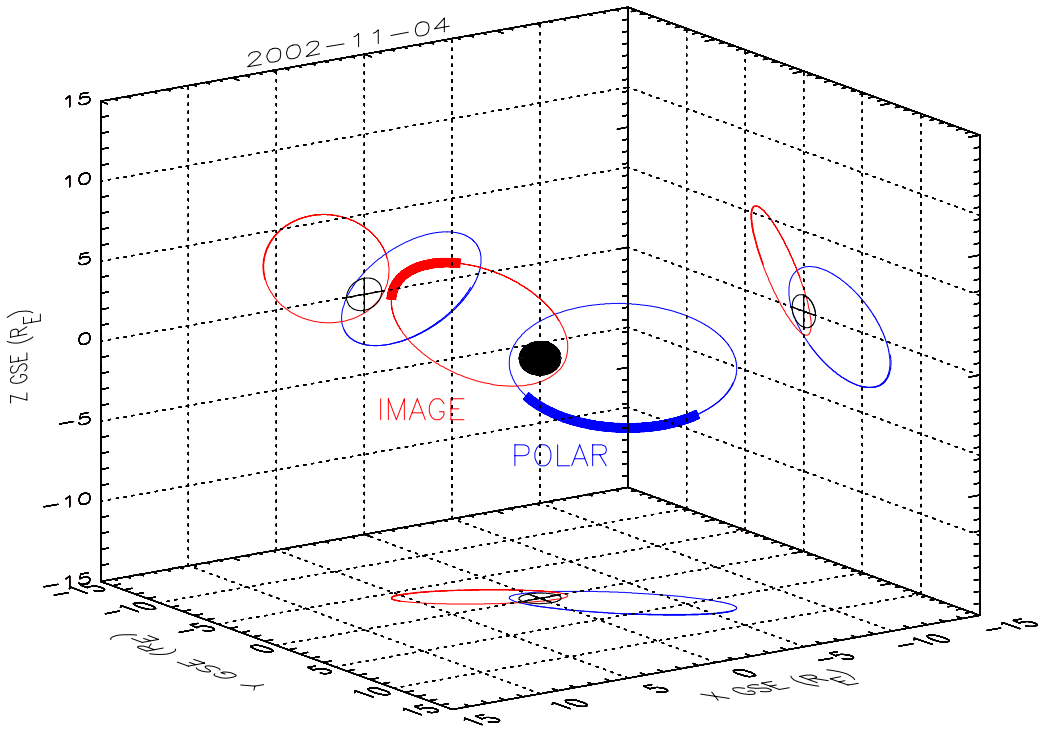
- We present the first simultaneous images of afternoon aurora from two global imagers in opposite hemispheres.

- Using these data, we are able to address the issue of conjugacy of afternoon aurora on a synoptic scale for the first time.

Spacecraft Orbits

<u>IMAGE</u>
Launch: March 25, 2000
Apogee: 8.2 R_E
Perigee: 1.15 R_E
Period: 14 hours

<u>Polar</u>
Launch: Feb. 24, 1996
Apogee: 9 R_E
Perigee: 1.8 R_E
Period: 18 hours



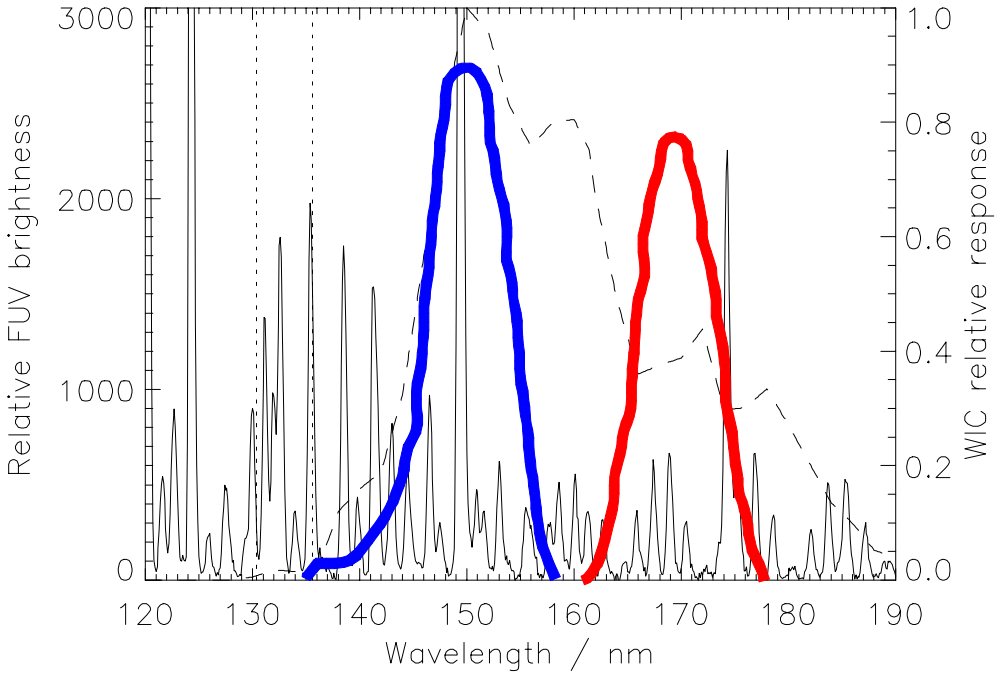
Instrumentation

IMAGE Wideband Imaging Camera (WIC) &
Polar Ultraviolet Imager (UVI) LBHS & LBHL

<u>Temporal resolution</u>
WIC: 10 second integration every 2 minutes
LBHS & LBHL: 18 & 36 second integration cyclic

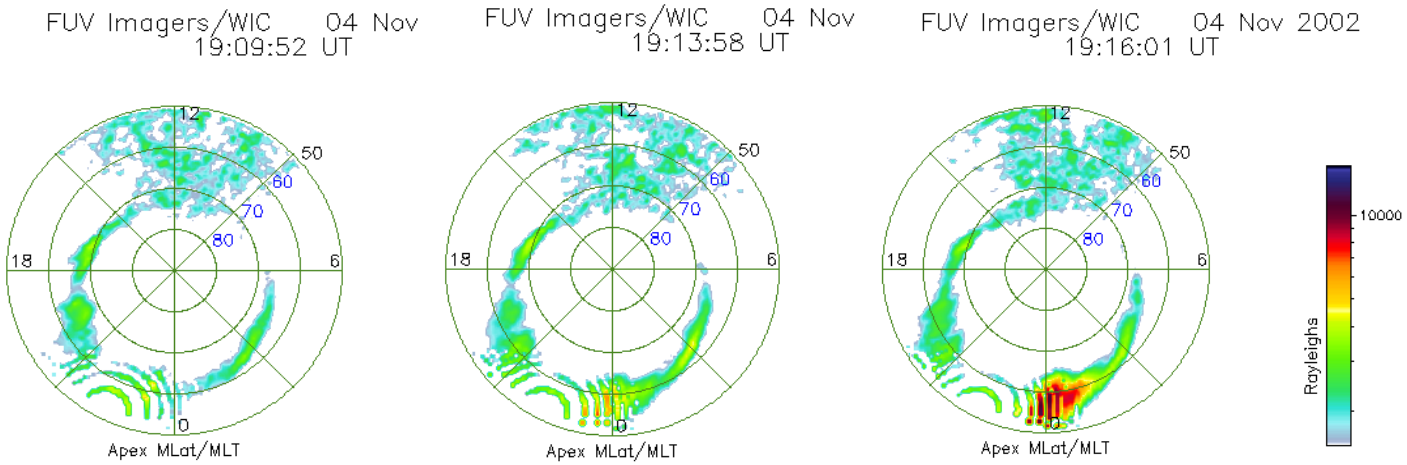
<u>Spatial resolution</u> (at apogee)
WIC: ~ 50 km
LBHS & LBHL: ~ 30 km

<u>Spectral resolution</u>
WIC: 140 to 190 nm ---
LBHS: 140 to 160 nm ---
LBHL: 160 to 180 nm ---

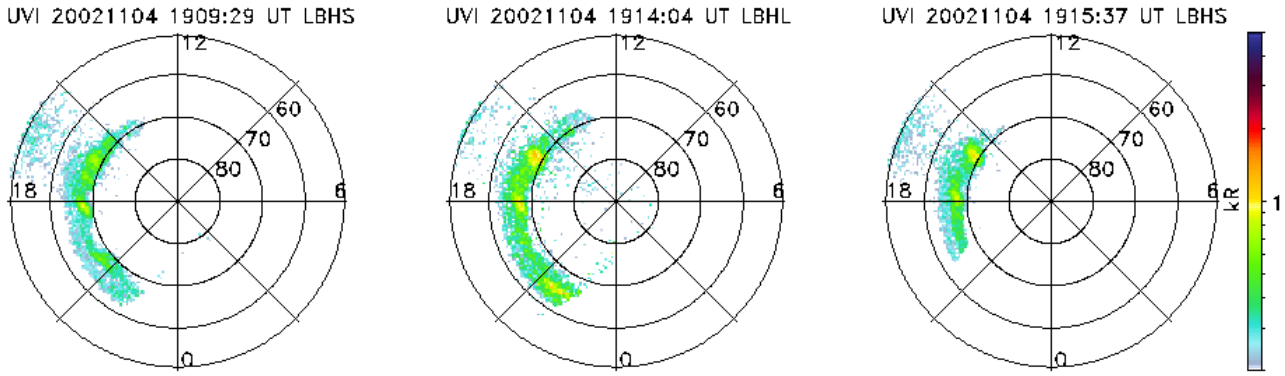


November 4, 2002

Northern Hemisphere

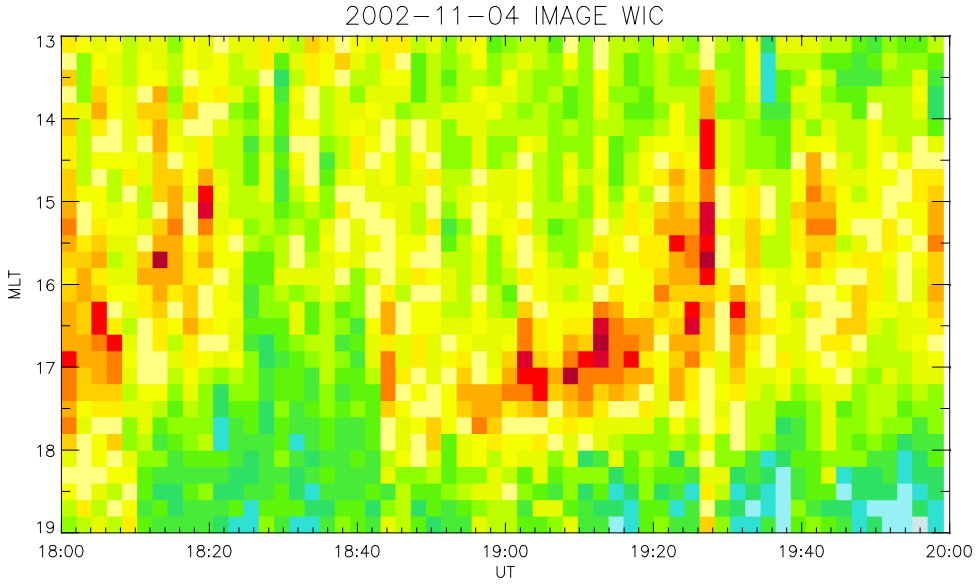


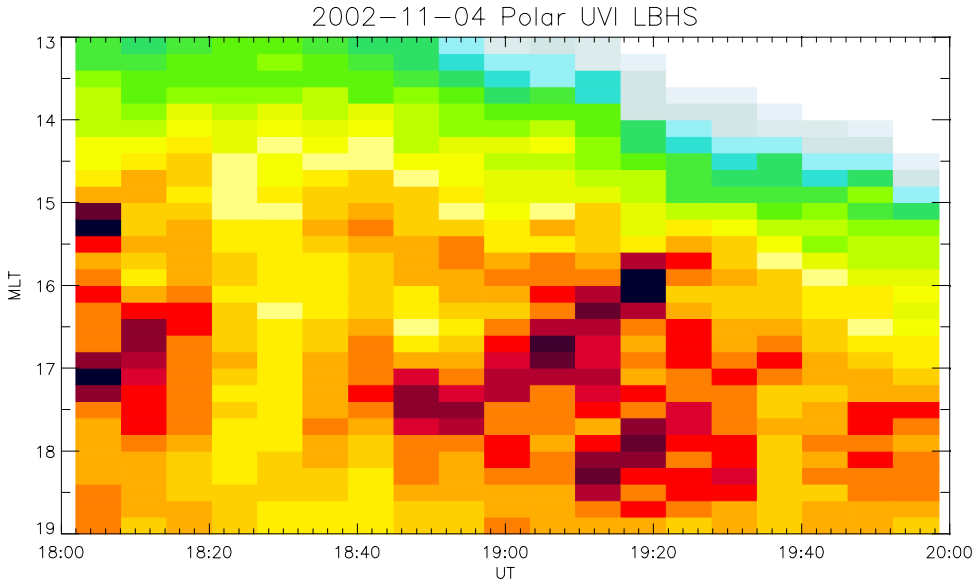
Southern Hemisphere



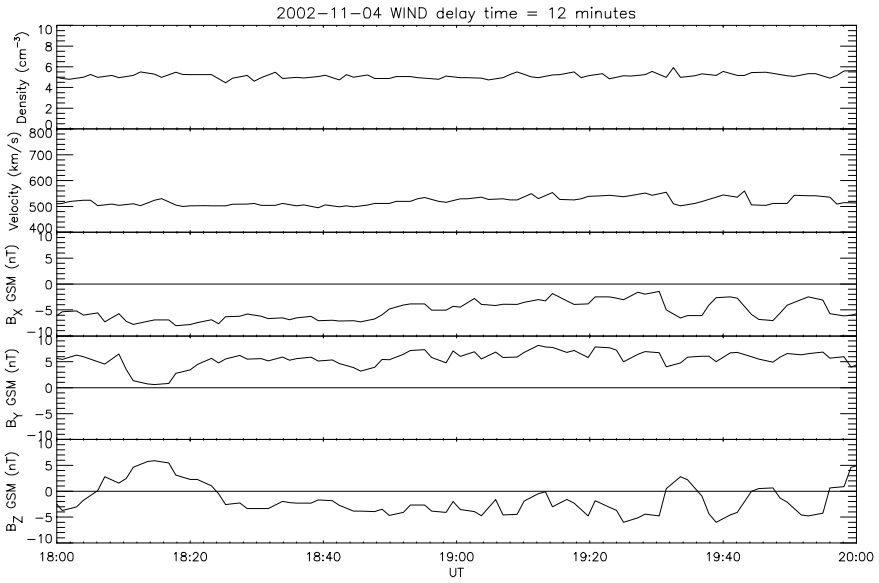
Northern Hemisphere: enhanced emission in afternoon (15 – 18 MLT)
emission unstructured

Southern Hemisphere: multiple spots ("string of pearls" configuration)
number, location, and intensity of spots change
on timescales of a few minutes





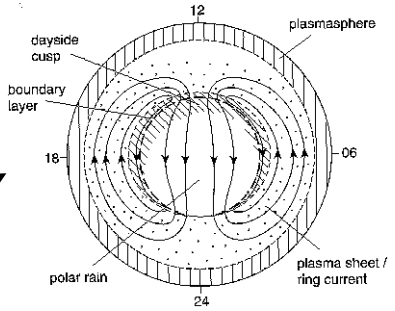
- Emission in both hemispheres
- Multiple spots only in south
- Trend toward noon



- Solar wind & IMF steady
- IMF $B_Y > 0$

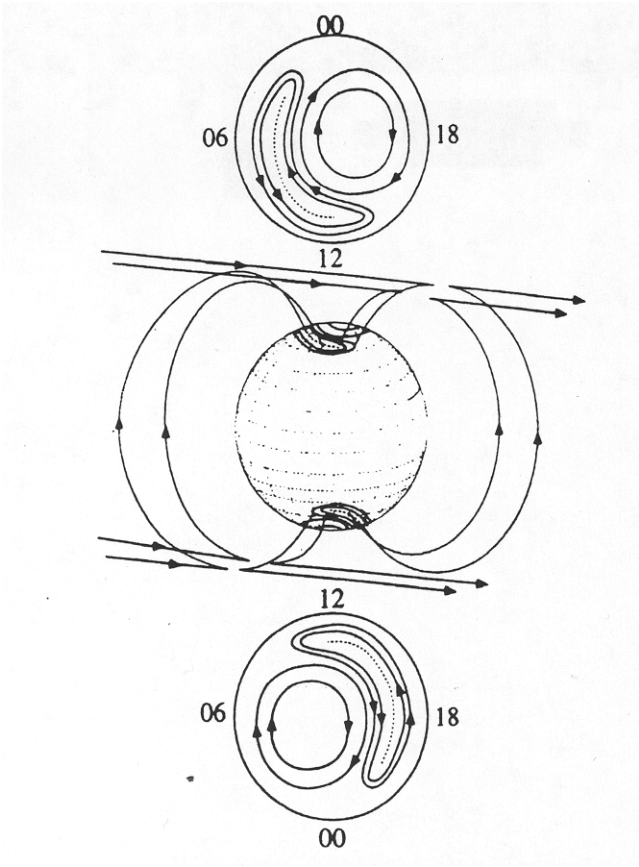
Interpretation

Interplanetary magnetic field influences ionospheric convection pattern:



For $B_Y \sim 0$, two symmetric circularly (or "D") shaped convection cells.

For $B_Y > 0$ (duskward), a crescent shaped cell on the dawnside and a circularly shaped cell on the duskside in the northern hemisphere and a circular cell on the dawn side and a crescent cell on the duskside in the southern hemipshere.



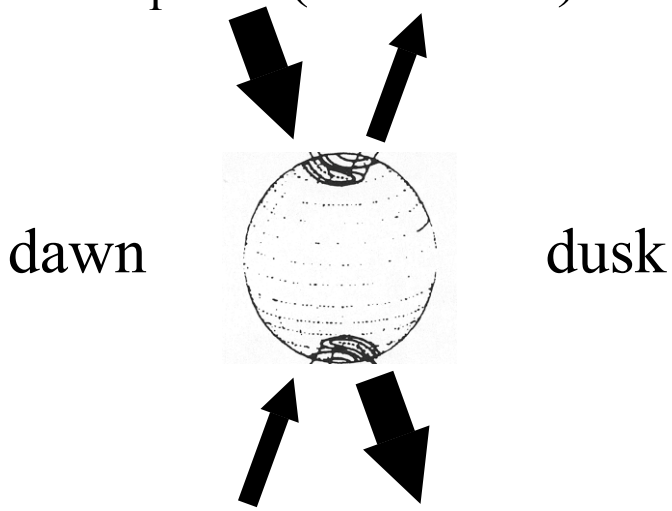
IMF merges with Earth's magnetic field and drags the footpoints of the magnetic field dawnward in the northern hemisphere and duskward in the southern hemisphere.

Interpretation (cont'd)

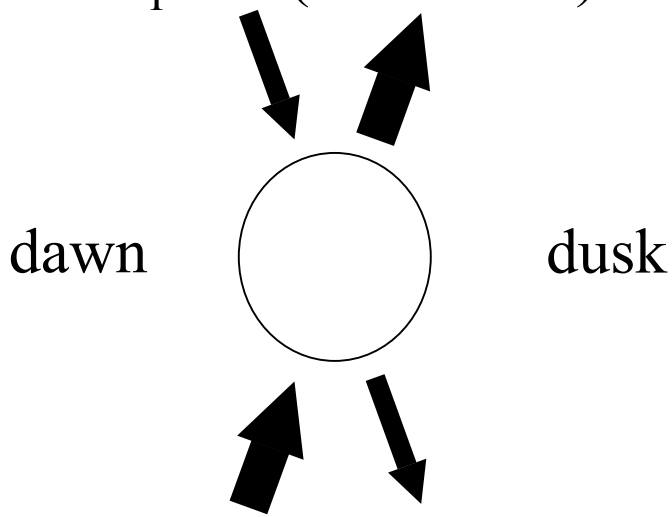
Convection pattern influences field-aligned current:

- Ionospheric electric field perpendicular to flow
- Converging (CW) and diverging (CCW) horizontal currents
  → Must be balanced by field-aligned currents (FACs)
- Stronger flow gradients (crescent cells) → stronger FACs

$B_Y > 0$ (duskward)



$B_Y < 0$ (dawnward)



Prediction: for $B_Y > 0$, afternoon aurora more intense in south;
for $B_Y < 0$, afternoon aurora more intense in north.

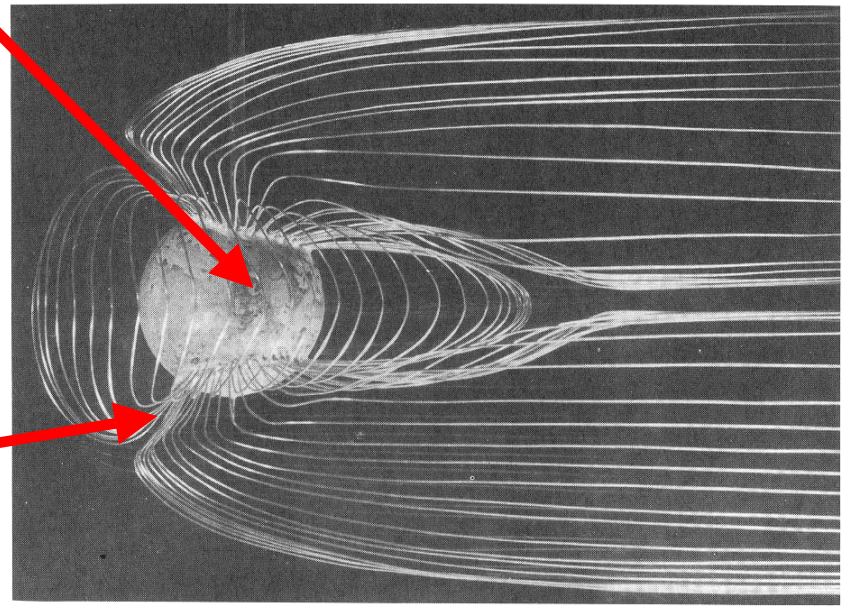
Why Spots in the Southern Hemisphere?

The presence of multiple auroral spots ("string of pearls" configuration) is consistent with being the result of Kelvin-Helmholtz Instability (KHI) Lui et al., 1989; Rostoker et al., 1992; Wei and Lee, 1993].

KHI occurs in regions of velocity shear and is assumed to be occur the equator.

Multiple spots only seen in one hemisphere, not both as expected if instability occurs at the equator.

We propose that the KHI occurs at high latitude near the ionosphere (crescent shaped convection cell).



Summary

- First global-scale conjugate observations of afternoon aurora
- Multiple spots only seen in one hemisphere → non-conjugate
- Predict conjugacy of afternoon aurora
  → depends on IMF direction
- KHI only operating in one hemisphere
  → High latitude, not at the equator

Future Directions

- Enlarge database (6 months of observations) → test prediction
- Other factors (e.g., ionospheric conductivity)
- Compare with ground-based radar observations (flow velocity)
- Compare with low altitude satellite current measurements
- Model KHI at low altitudes
- 2 global imagers with identical instrumentation